

# **Update on IEEE Standards and NREL/NTS Testing Activities**

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**DOE Distributed Power Program**

**DOE Program Manager: Joe Galdo**

**NREL Technology Manager: Dick DeBlasio**

# IEEE P1547 Update

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- Last Meeting – April 18-20, New Orleans
- Ballot results – 91% returned out of 167 ballot members
- Ballot results – 66% Affirmative (Need 75%)
- Writing Committee met June in Chicago to discuss changes
- Recirculation of Draft 7 with ballot feedback - expected in September
- Next Meeting of SCC21 and P1547 – October 15-19  
Embassy Suites Hotel -- Las Vegas Convention Center  
3600 Paradise Road  
Las Vegas NV 89109

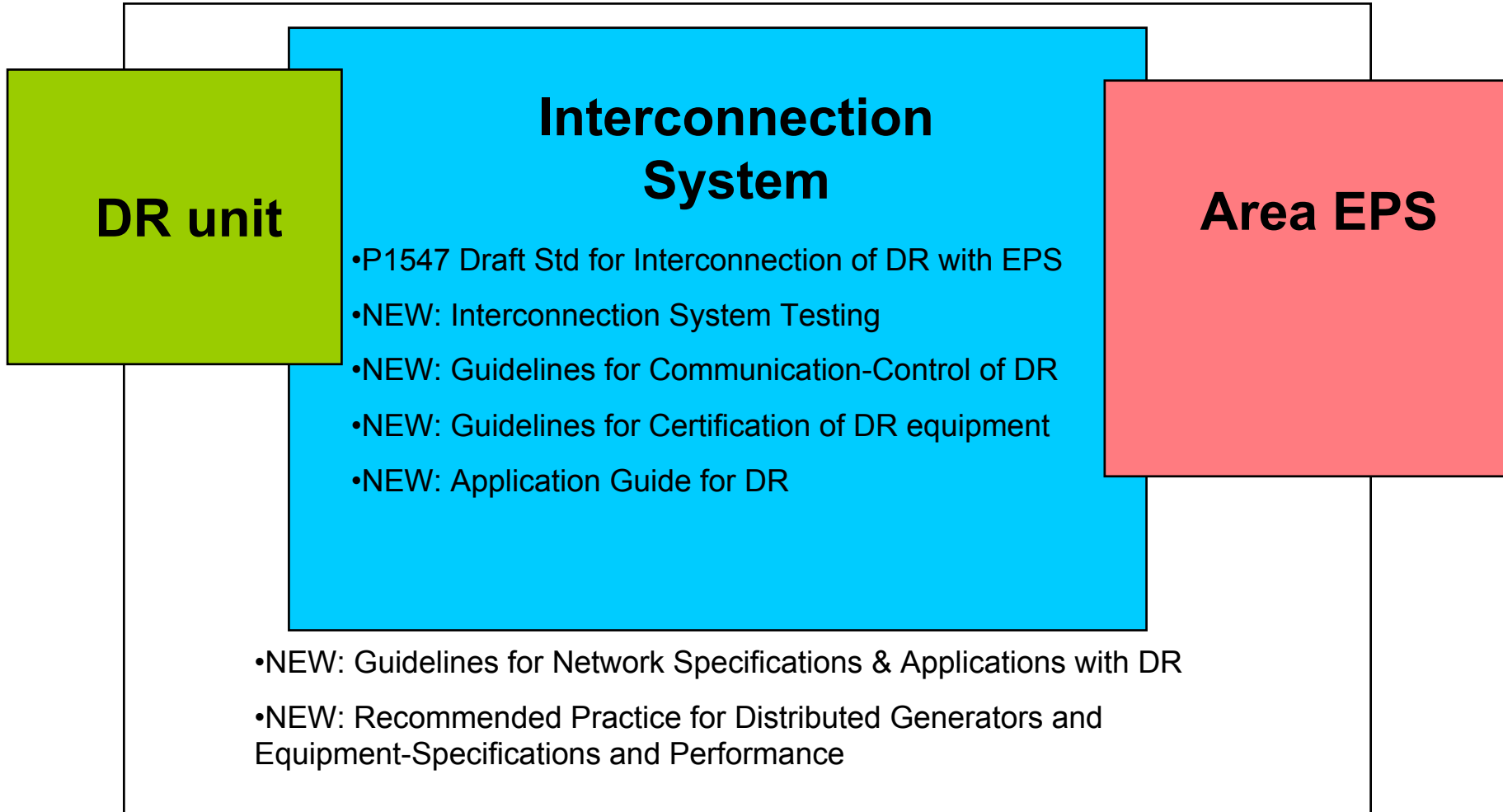
# **IEEE P1547 Key Issues**

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- **Minimum vs. Maximum Requirements**
- **Field Testing vs. Type Testing**
- **Secondary Grid and Spot Networks**
- **Grid/DG Monitoring and Control**
- **Voltage Regulation/Stability**
- **DG Penetration/Aggregation**

# Prospective New IEEE DR Activities

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# Testing Standard – P1589

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On June 14, 2001 **P1589** *Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems* was approved by the IEEE-SA Standards Board until December 2005.

**Chair:** David Leslie – GE Zenith Controls

**Secretary:** Ben Kroposki - NREL

## **SCOPE:**

**This standard specifies the type, production, and commissioning tests that shall be performed to demonstrate that the interconnection functions and equipment of a distributed resource (DR) conform to IEEE Standard P1547.**

## **PURPOSE:**

**Interconnection equipment that connects distributed resources (DR) to an electric power system (EPS) must meet the requirements specified in IEEE Standard P1547. Standardized test procedures are necessary to establish and verify compliance with those requirements. These test procedures must provide both repeatable results, independent of test location, and flexibility to accommodate a variety of DR technologies.**

# DOE Distributed Power Program

NREL – Lead Laboratory

Interconnection Testing Activities (In-House and Subcontract)

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## Simulation and Modeling

University of Wisconsin  
Orion - University of Massachusetts (Lowell)  
Industry Partners - DTE, GE, NiSource

## Characterization R&D

NREL - DER Test Facility  
EPRI - PEAC  
University of Wisconsin

## Certification

EPRI-PEAC  
Underwriters Laboratories

## Field Testing and Validation

Nevada Test Site  
Distributed Utility Integration Test - DUA  
Industry Partners - GE, NYSERDA, GRI, NRECA,  
NiSource, Real Energy, DTE

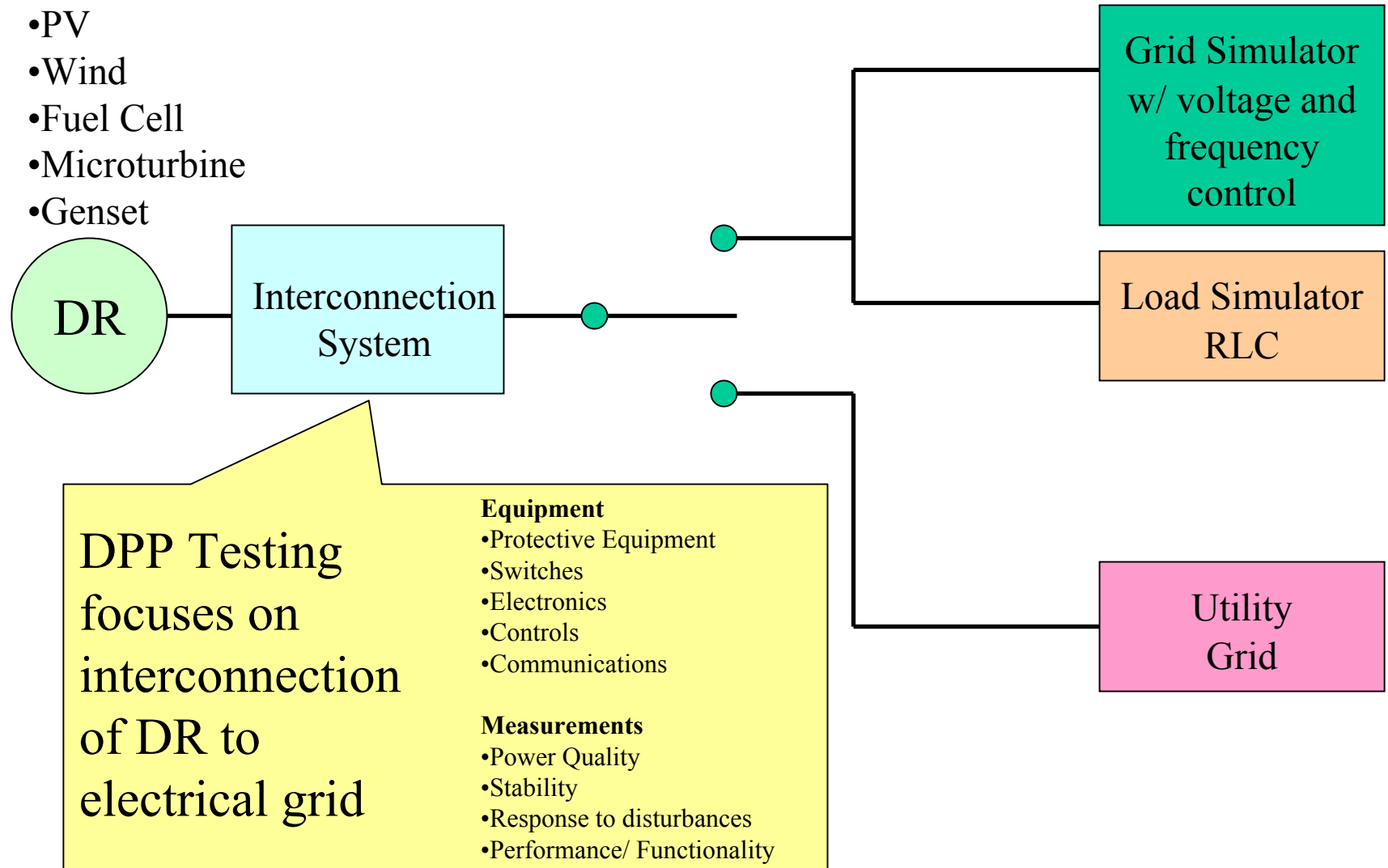
# Purpose of the NREL Distributed Energy Resources Test Facility

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- Support DOE Distributed Power Program goals.
- Capitalize on NREL's expertise and expand capabilities in testing renewable and distributed energy systems.
- Continue leadership with industry in standards development and validation for distributed resources (P1547, P1589, ...).
- Support research subcontracts and aid manufacturers of distributed generation equipment through cooperative testing of their systems for baseline comparisons to identify advances in functional performance.
- Coordination of testing at field sites.

# Testing Conducted in DP Program

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# P1547 Standard – Validation Testing

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IEEE P1547 Specifications, Requirements and Tests that will be conducted at the DER Test Facility

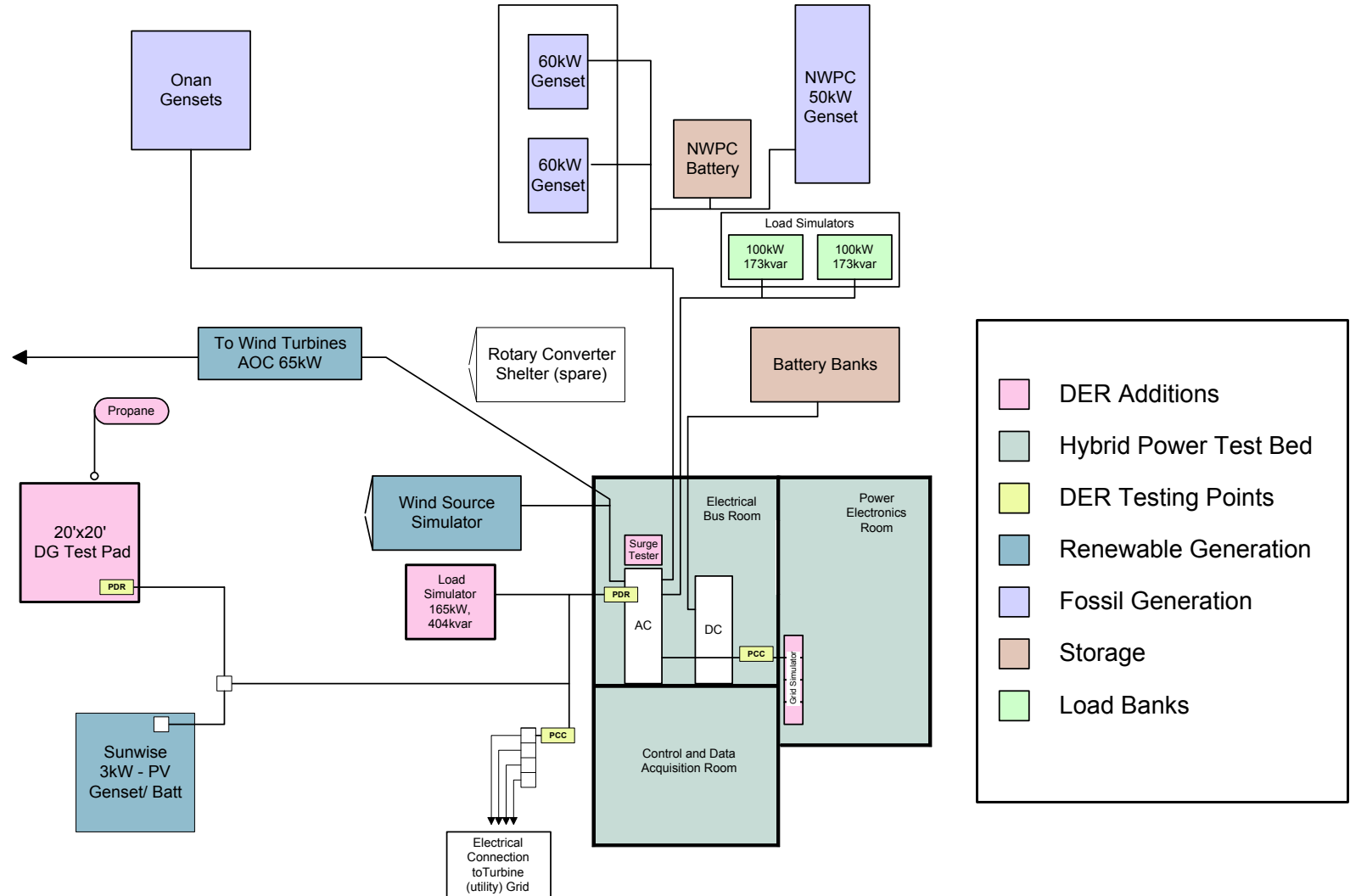
<b>General (Section 4.1)</b>		
<b>Technical Specifications and Requirements</b>	<b>Test Specifications and Requirements</b>	<b>Tests</b>
4.1.1. Voltage Regulation		
4.1.2. System Grounding	5.3.1	Design Verification/ Visual Inspection
4.1.3. Synchronization	5.1.1	
4.1.4. Secondary Grid and Spot Networks		
4.1.5. Inadvertent Energization and Reconnection		
4.1.6 Monitoring	5.3.3	Design Verification
4.1.7 Isolation Device	5.3.2	Visual Inspection
<b>Response to Abnormal Conditions (Section 4.2)</b>		
4.2.1 Voltage Disturbance	5.1.2	A.1, A.2
4.2.2 Frequency Disturbance	5.1.2	A.3, A.4
4.2.3 Disconnection for Faults		
4.2.4 Loss of Synchronism	5.1.3	
4.2.5 Feeder Reclosing Coordination	5.3.4	Design Verification
<b>Power Quality (Section 4.3)</b>		
4.3.1 DC Current Injection	5.1.4	5.1.4
4.3.2 Voltage Flicker	5.4.6	IEC 61000-4-15
4.3.3 Harmonics	5.1.5	5.1.5
4.3.4 Immunity Protection	5.1.6	IEEE C37.90.2
4.3.5 Surge Capability	5.1.7	IEEE C62.45
<b>Islanding (Section 4.4)</b>		
4.4.1 Unintentional Islanding	5.1.8	A.5
4.4.2 Intentional Islanding		

# **NWTC Site View and Location of HPTB - DERTF**



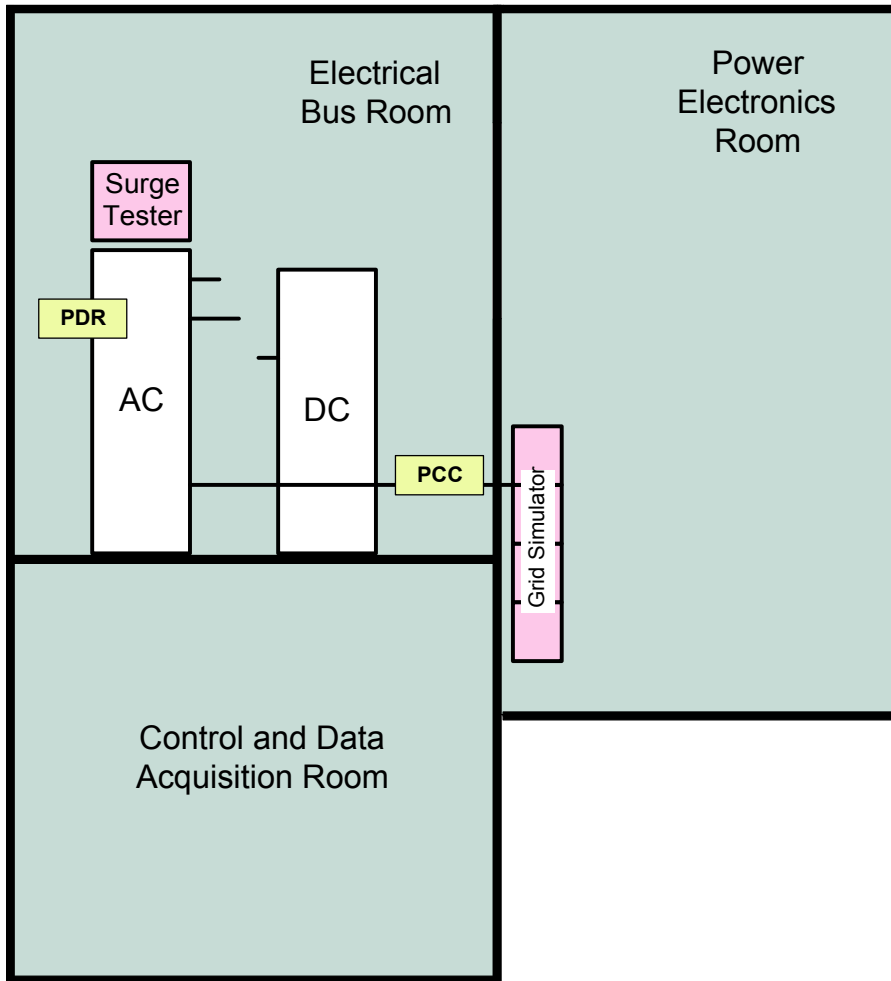
# NREL DER Test Facility (Phase 0)

Co-located with Hybrid Power Test Bed at NWTC



# FY01 DER/HPTB Additions

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- Increase lab space by 750 sqft.
- New concrete pad for testing DR equipment (microturbines, fuel cells, propane/CNG gen-sets, integrated battery/inverter sets, inverters).
- Propane Tank includes regulators, fittings, hoses
- Natural Gas line due in FY02
- Electrical equipment includes wire, conduit, junction boxes, contactor, isolation transformer, disconnects, connections to hybrid grid and utility grid via transfer switches

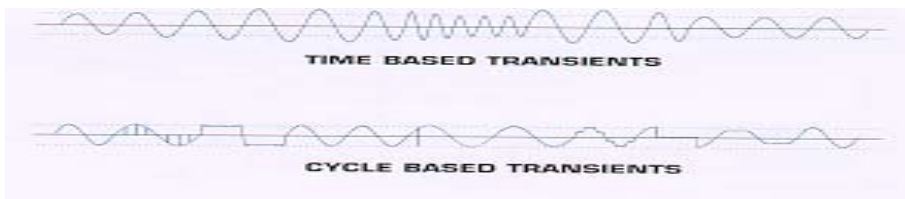
# FY01 DER/HPTB Additions

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## Grid Simulator (Pacific Power Supply)



- 200kW Power - can be increased to 500kW easily
- Connects to 480V hybrid grid
- Allows full control of voltage and frequency levels
- Can simulate voltage sags/swells and transients
- Programmable dynamic output impedance
- Harmonic Analysis of Output and ability to create waveforms



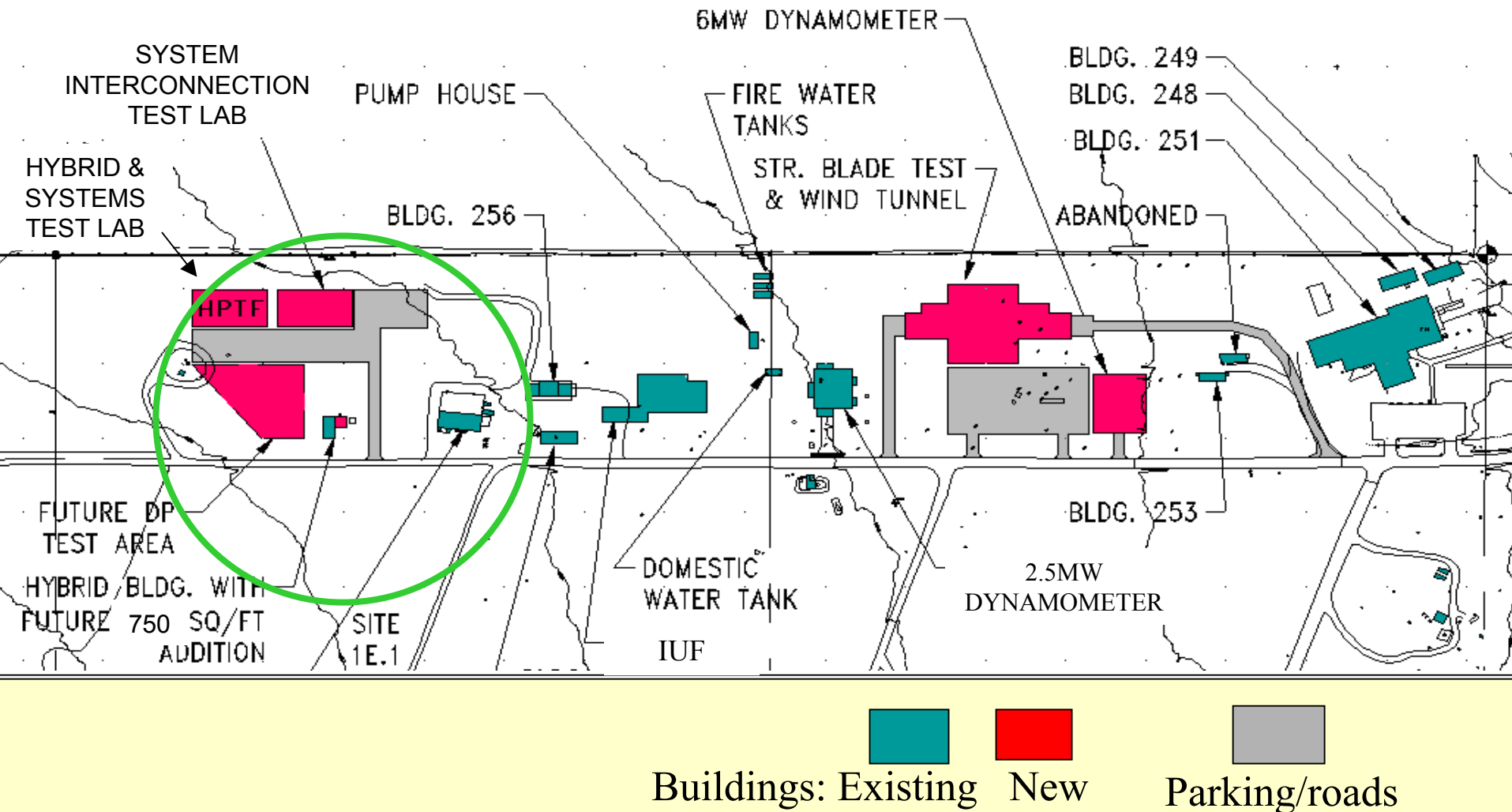
# Update on NREL DER Test Facility (Phase 0)

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- New 20'x 20' Concrete Pad for DG Testing has been installed
- Concrete has been poured for floor of Hybrid Power Test Bed expansion - Building electrical and structural designs completed
- Have received the following GPP/GPE equipment:
  - 200kW Grid Simulator
  - KeyTek Surge Tester
  - Yokogawa PZ4000 - Power analyzer
- Completed review of testing electrical designs completed
- Start Testing September 2001 – Capstone Turbine, Trace Inverter

# Location of Planned Distributed Energy Resources Test Facility at NWTC



# Description of Planned DER Test Facility

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## **Phase I - System Interconnection Test Lab (10,000 sqft)**

- Focused on development and validation of interconnection standard testing methods and procedures and electrical details, safety, grid compatibility.
- This testing would be technology independent and focus on the connection of the distributed power source with the electrical utility grid and other sources.
- Coordination of data with network of remote sites from testing partners and subcontracts.
- Capacity up to 1MW.

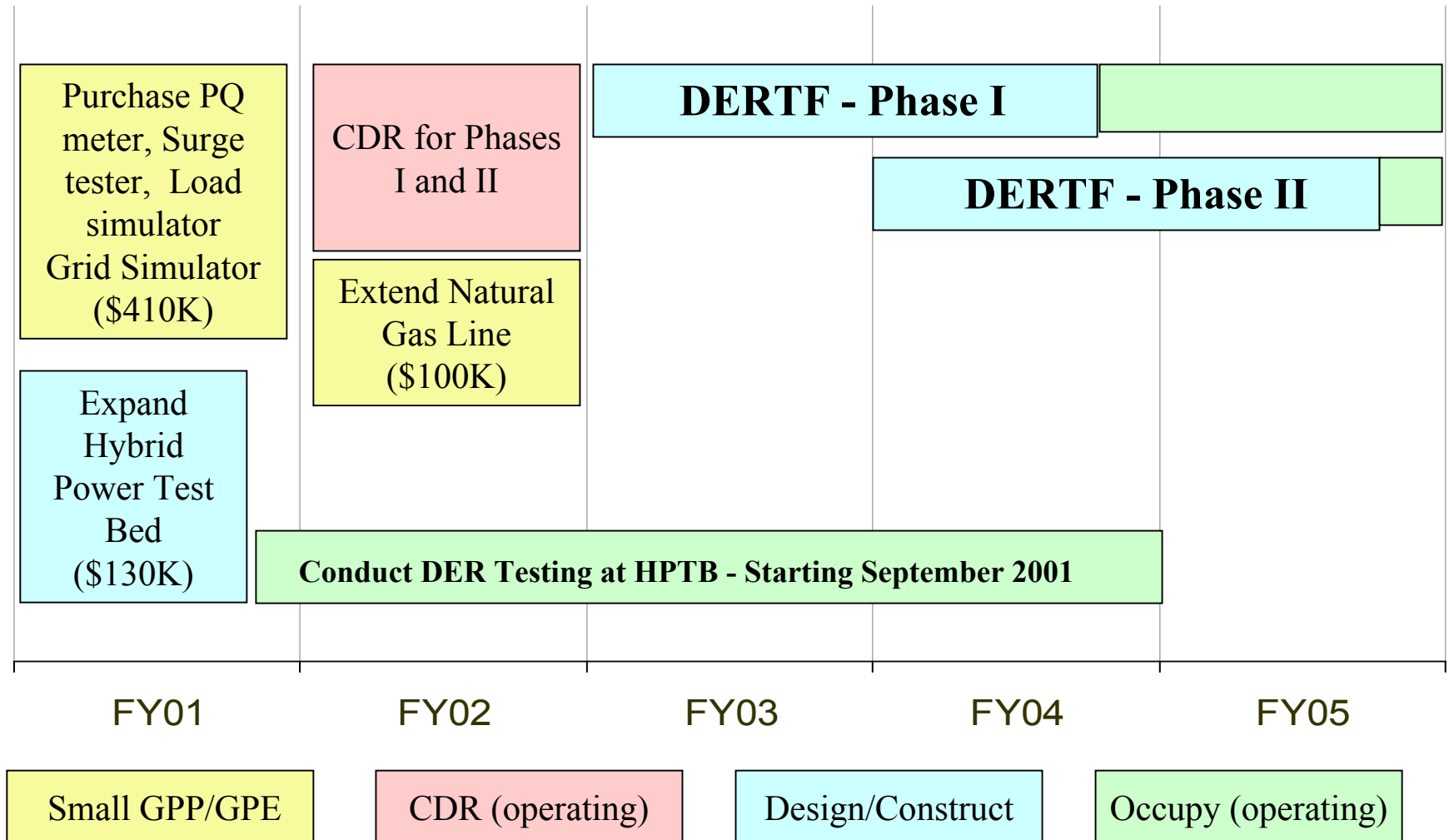
## **Phase II –Hybrid and Systems Test Lab (10,000 sqft)**

- Focused on the long-term performance, reliability, availability, and efficiency of clean energy and renewable hybrid systems.
- Testing of advanced design technologies and configurations (grid connected/ stand-alone/ hybrid).
- These systems would include: PV, Wind, Fuel Cells, Microturbines, Concentrated Solar Power, Storage, Combined Heat & Power, modular biomass, flywheels, etc.
- Increased capability for testing larger devices up to 10 MW.



# NREL DER Test Facility Plan

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# DPP Testing at Nevada Test Site

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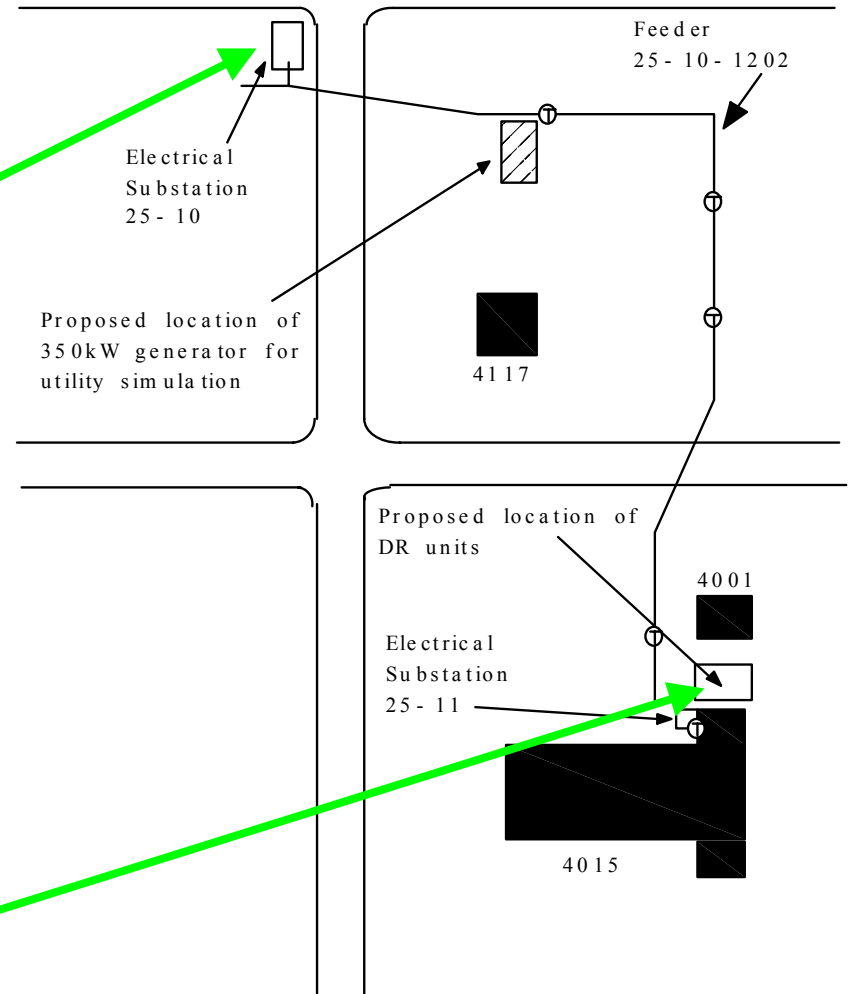
NREL Distribute Power Program is conduct exploratory field tests to validate interconnection and commissioning tests included in the IEEE P1547 interconnection standard at the Nevada Test Site. NREL is also developing a long-term testing plan for NTS.

The near-term testing that will be conducted includes:  
Over Voltage, Under Voltage, Over Frequency, Under Frequency, Trip Test, Harmonics, DC Current Injection, Unintentional Islanding, Synchronization

Plans are to test 3 different types of DG:

1. Static Inverter (Trace 5-10kW)
2. Rotating machine with inverter (30kW Capstone microturbine)
3. Synchronous generator (60kW –100kW diesel gensets w/parallel package).

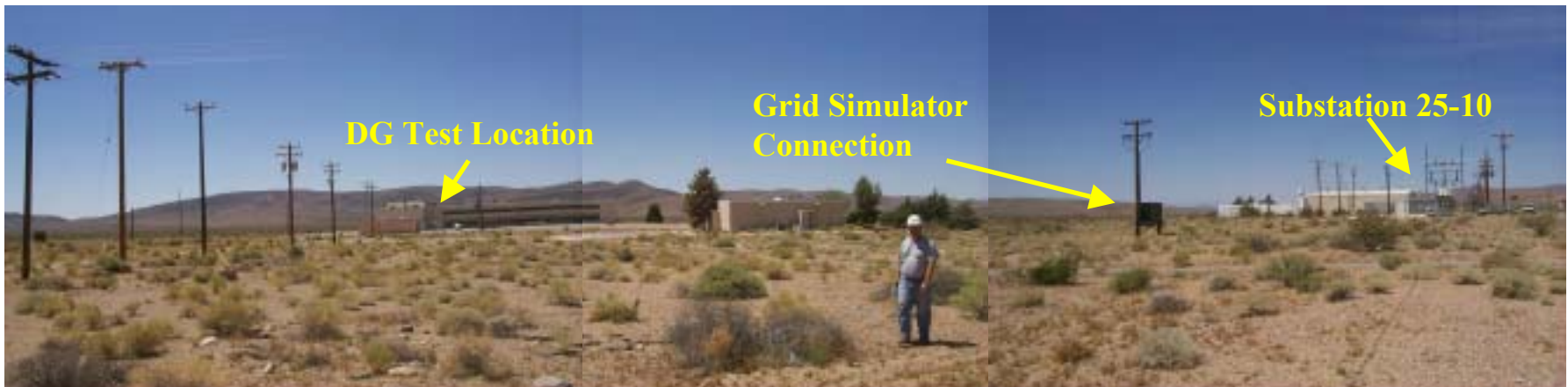
# DPP Testing at Nevada Test Site



# Update on Nevada Test Site DPP Testing

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- Completed Initial Test Plan
- Coordination Meeting (May 23-24) with NREL, DOE/NV, Bechtel/NV, DUA on test plan and site development
- Bechtel/NV delivering photos /updated one-lines and pricing system installation
- NREL designing portable DAS for measurements
- Testing scheduled for October 2001



Feeder 25-1202 at Area 25 of Nevada Test Site

# DPP Testing at Nevada Test Site

Substation 25 - 10

25 - 10 - 1202

